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ABSTRACT

Research on how communicating human beings produce and understand language has focused mostly on what language is, less on how language is processed, and little on who produces and understands language. However, the interaction between what, who, and how is very significant. The importance of who does languaging is related both to the cognitive capability of the person and to the social matrix in the communicative use of language. As the computational paradigm of communication differs from human cognition of meaning, it is restricted in its ability to explain how human beings do languaging. On the other hand, as the human behavior paradigm ignores the communication process, it is limited in its usefulness: it ignores the who of communication. Cognition and communication are jointly necessary for human languaging. The interrelationships of who, what, and how, of individual and social components, of cognitive constraints and communicative constraints, and of the computational paradigm and the human behavior paradigm indicate that research on human languaging must be an interdisciplinary venture. (TJ)

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MOVES TOWARD A "COGNITIVE GRAMMAR": SOME IMPLICATIONS OF LINKING GRAMMAR WITH COGNITIVE REPRESENTATION

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A basic assumption of this paper is that it would be valuable to be able to understand and explain how communicating human beings produce and understand language. "Languaging" is not all that human beings do, but in the particular form in which we do it, it serves to distinguish our species. In broad outline, I will suggest that we now understand a considerable amount about WHAT constitutes human language, and that there is underway an important shift toward investigating HOW humans produce and understand it. But I will argue that our ability to explain HOW language is processed will be limited unless we also consider fully the constraints imposed when communicating human beings process language. In short, to attain the goal set out above, we must also know more about the capabilities of WHO produces and understands language. Considering WHO strongly influences our understanding of HOW (and WHAT), and carries important implications for research on language in both cognitive psychology and human communication.

WHAT, and the move toward HOW

Linguistics has been the primary source of understanding regarding the structure of human language, or WHAT language is. In Chomsky's terms (for example, 1972, p. 116), linguistics studies the link between sound and meaning. But as he must continually remind those who would construe him otherwise, linguistics does not study HOW humans produce or understand language forms. Instead, transformational linguists model those structural properties which native speakers must implicitly "know" about their language

in order to use it. And the primary empirical constraints on this modeling are that the derivation produced by the grammar for a given sentence correspond to a native speaker's (usually the linguist's) judgments that the sentence (a) is grammatical or not, (b) is ambiguous or not, (c) is a paraphrase of another sentence, or (d) shows certain basic grammatical relationships (Cairns and Cairns, 1976, Ch. 2).

Other models could explain these judgments and perhaps more, but it is at this point that transformational linguists leave to others the task of modeling HOW speakers actually "assemble" language forms in expressing a meaning, or "disassemble" a sentence in creating a meaning. Indeed, the "meanings" to which transformational grammars establish a link are simply dictionary definitions comprised of verbal features or characteristics, and of substitutable descriptions. Arguments that verbal paraphrases are inadequate to represent meaning in anything but a trivial sense are numerous, several of which are referenced here without further comment (Benjamin, 1970, pp. 81-97; Berlo, 1960, pp. 173-178, 193-196; Campbell, 1975; Franks, 1974, pp. 245-256; Weiner, 1974, pp. 424-425). Given the focus on the structural properties of language, however, such a "paraphrase semantics" has not generally hindered linguistic research (though see Maclay, 1971, and Martin et al., 1974, on the future).[1] And there is little question that in twenty years transformational linguistics has added a great deal to our knowledge of WHAT constitutes human language.

Of course not all linguists agree with Chomsky's views on transformational theory, in particular, or on linguistics, in general. Lakoff and Thompson (1975b), for example, argue that

linguistics must focus on the link between the linguistic signal and the "cognitive representation of meaning." They envision a linguistics in which "grammars are just collections of strategies for understanding and producing sentences (p. 295)," and they outline a "cognitive grammar" that would model the actual processing of language forms and would, in principle, be constrained by a broad range of empirical findings on such processing. Lakoff and Thompson's proposal for a cognitive grammar represents an important move by some linguists away from the predominant focus on WHAT language is, and toward a concern with HOW humans produce and understand it. But in making this move they fail to examine fully the implications of seeking a link to the "cognitive representation of meaning," one of which is the need to abandon the paraphrase semantics that Lakoff has employed in his earlier work and apparently intends for cognitive grammar (see Lakoff and Thompson, 1975a).

Unlike linguists, psycholinguists have been primarily concerned with explaining HOW humans actually process language, since understanding the distinctive capability to "do languaging" is fundamental in understanding human behavior in general. Explaining HOW presupposes an understanding of WHAT is being processed, however, so that since the advent of transformational linguistics, psycholinguistics has generally followed its lead (Weimer, 1974, p. 421). When it soon became clear that (despite Chomsky's indications) transformational grammar did <u>not</u> model HOW humans actually process language, psycholinguists came to view their task as one of building an autonomous model of language processing, but one which still closely reflected the structure of language as seen by linguists (Cairns and Cairns, 1976, pp. 145-161). The results

regarding cognitive strategies for HOW sentences are "disassembled" have been interesting, but provide only glimpses of what a complete model would involve. And the results concerning strategies for "assembling" sentences are sufficiently scattered that they provide no model at all. Similarly, there has been only scant attention to problems of meaning in language processing, presumably because of transformational linguistics' preoccupation with syntax, and because its paraphrase semantics is at best a weak base for research on human meaning processes.

In view of the research sketched above, then, there is an apparent impasse in reaching the goal of understanding and explaining how communicating human beings produce and understand language.[2] Transformational linguists are concerned with WHAT constitutes language, not with HOW humans process it. Linguists who would focus on problems of HOW it is produced and understood remain bound by linguistic approaches to meaning. And psycholinguists, while primarily concerned with HOW humans process language, have nevertheless been strongly influenced by the transformational linguist's view of WHAT language is, and thereby of WHAT meaning is. The impasse has not gone unnoticed (Franks, 1974, pp. 245-256; Maclay, 1971; Martin, 1974; Rommetveit, 1974; Weimer, 1974, pp. 421-425, among others).

New foci on HOW

Cognitive psychology will not be the way out of the impasse. But it holds with psycholinguistics the focus on HOW humans operate, perhaps more strongly because of its epistemological distinction from strict behaviorism. And unlike psycholinguistics at

present, it is clearly concerned with problems such as those surrounding human meaning. As a consequence, two recent programs of research in cognitive psychology suggest directions for circumventing the impasse. A brief sketch of each will be useful in current and future discussion.

Several years ago, George Miller (1974) urged psycholinguists to adopt a "new" metaphor for their work -- the computational paradigm -- which has deep roots in cognitive psychology.[3] Taking the injunction seriously, Miller and Johnson-Laird (1976) have recently developed a "procedural semantics" -- an extended and highly detailed model of meaning. Briefly, the meaning of a word is represented in part as a set of procedures (a schema) for determining the presence of a pattern of perceptual and functional characteristics of the word. But the procedures which identify a single word are also interwoven with the procedures for other words so as to form larger semantic fields. These, in turn, are organized around a set of higher level "core concepts" that both provide integration and reflect deeper conceptualizations or "beliefs" about the world. Thus the meaning of a word is represented both in ties to the perceptual world and in links both to other words at the same level and to concepts at a higher level.

The meaning of a word is "computed" by executing the procedures or schema for identifying the word, which in turn implicates the links to other words and higher concepts. Other procedures for operating on the core concepts provide links to the lower level words. Miller and Johnson-Laird (1976) provide not only a highly general theory (and methodology), but also a detailed analysis of

specific words in a large portion of the English lexicon. And Johnson-Laird (1977) has recently outlined a procedural approach to processing sentences which embeds the above approach to processing words. Procedural semantics is not without problems, as considered later, but this program of research does represent a major attempt to model HOW meanings are processed in the producing and understanding of language.

A somewhat different perspective on these issues is that provided in the research program of John Bransford and colleagues, summarized in part in Bransford and McCarrell (1974). This work employs what might the called the "human behavior paradigm" in cognitive psychology, in that the models developed are not necessarily expressed using the formalisms of computational procedures, and are generally tested by conducting "direct" studies of human behavior, as opposed to first carrying out a computational simulation and then comparing the outcomes with behavior. The work reported by Bransford and McCarrell has focussed on the understanding of sentences, with particular attention to the role of nonlinguistic knowledge in comprehension. Their results point to a model in which, at the linguistic level, sentences specify conditions on the relationships and on the entities that enter into them. But they demonstrate that it is the receiver's nonlinguistic knowledge of the entities, together with his/her ability to create or recognize a context in which the specified relation can be realized, that allows him/her to comprehend what the sentence might mean.

Thus the words in a sentence like "The haystack was important because the cloth ripped (p. 209)," will be recognized by the receiver, but the sentence will not be processed as meaningful unless he/she is provided with or creates a context like "parachute." Bransford and McCarrell's approach is strongly grounded in perceptual psychology, hence they maintain that these comprehension processes operate for all sentences. "The haystack was important because the cattle were starving," is unproblematic only because receivers can so readily supply the knowledge of the world needed to realize the specified relation. Bransford and McCarrell's work provides an important theoretical base for studying sentence comprehension (not just word comprehension), the effects of context, and the understanding of metaphor, all of which have posed formidable problems in recent linguistics and psycholinguistics. Some limitations in this work will be considered later, as well, but this research program also provides important departures in studying HOW human beings process or create meaning in using language.

The importance of WHO in studying language

The programs of Miller and Johnson-Laird and of Bransford and McCarrell thus represent two promising perspectives on the problems of HOW humans actually process language and of WHAT meaning is -- the two problems which seem to have brought recent psycholinguistics to an impasse in seeking to understand and explain how communicating human beings produce and understand language. But as presently constituted, neither these two research programs, nor other moves in cognitive psychology toward a

"cognitive grammar" or a "cognitive semantics," will be sufficient to eliminate the impasse. Such research into HOW language is produced and understood must continue, but it is not likely to make further significant moves toward the goal until researchers consider carefully the capabilities of the communicating human beings in which language producing and understanding is embodied, or in short, until they fully take into account WHO does languaging.

Why should a consideration of WHO, or of the nature of the entity that embodies a process be so important? Very simply, and by analogy, because only programs that are constructed within a restricted set of formats will execute on any given computer. The embodiment or the WHO that carries out the process places constraints on WHAT can be done, as well as on HOW it can get done. Shaw and McIntyre (1974) argue that the WHAT, HOW, and WHO questions are a closed set, with strong interactions. That is, the act of asking HOW a process is accomplished provides information on and constraints for WHAT can be processed (cf. Hawes, 1977, pp. 36-37). But more important, because it is often neglected, asking WHO does a process reveals constraints on and may modify one's approach in asking the WHAT and HOW questions.

Note that the concern here is with <u>constraints</u>: the structure of the entity which performs a process limits the types of procedures that can be implemented, as well as the "things" that can be processed, but it does not necessarily uniquely determine them. The constraints arise not from some "unanalyzable metaphysical 'spook' or ghost in the biological [or physical] machine (Shaw and McIntyre, 1974, p. 310)," but from the finite capabilities of actual organisms or machines. More specifically, Shaw

and McIntyre (pp. 318-319) show that the class of processing models or "procedures" which are in principle capable of executing a particular psychological function is larger than the class of procedures that can be actually implemented or realized in the human organism, given the limitations of real time, space, and structure imposed by evolution. In addition, the class of procedures in principle capable of performing a specific function is larger than the class that can actually process the particular energy distributions or information arrays to which the human organism responds, again given the finite structure provided by evolution.[4] It is in this sense, then, that the nature of WHO actually carries out a process (like producing and understanding language) not only directly constrains HOW that process can be done, but also mediates the system of constraints including both HOW and WHAT it is that is processed. The primary concern in this paper is with the direct constraint of WHO on HOW -- the first of the above pair of general constraints. But this focus is entirely a matter of emphasis, for it is clear in what has been said above and in what follows that the concern with WHAT cannot be eliminated.

It would be misleading to suggest that in studying HOW language is processed, cognitive psychologists and psycholinguists have ignored the constraints imposed by WHO does languaging. The models of both Miller and Johnson-Laird and of Bransford and McCarrell, for example, are partially constrained by their grounding in human perceptual processing. But at this point in time, the predominant concern of these researchers and others appears to be to develop some type of model of HOW language processes are

carried out.[5] Relatively little attention has been given to WHO does the processing, and almost none to the specific constraints on models that arise from the human embodiment of language processing. Unless these constraints are more fully identified and brought into consideration, the ability to explain HOW language is processed (and WHAT it is) will be limited. Limited, that is, not in the number of possible models, but in the ability of those models to explain human languaging.

The constraints on HOW imposed by WHO does languaging fall into two classes: those stemming from the cognitive capabilities of human beings in using language, and those stemming from the communicative use of language in a social matrix. Both sets of constraints need to be examined, as does the nature of their interaction, before turning to the implications they hold for research on language.

The importance of cognitive capabilities as one aspect of WHO does languaging arises from what should be an obvious insight: human beings are the only users of human language.[6] But Shaw and McIntyre (1974) make quite clear that the parallel insight for human perception has been anything but obvious to cognitive psychologists, so that many current models of HOW perception takes place are not fully constrained to the cognitive capabilities of human perceivers. The situation is very similar for models of HOW language is processed. Failure to take into account the constraints imposed by the finite nature of human cognition may lead one to a model that represents how a particular computational formalism or abstract model processes human language, but not how humans do it. Such a model would be of limited utility

in achieving the goal identified at the outset.

The importance of the communicative use of language as an aspect of WHO does languaging arises from another seemingly obvious insight: there would be no human language whatsoever in the absence of other human beings to communicate with. The fact that language arises in and is maintained through interaction in a social matrix has generally escaped notice in recent linguistics, psycholinguistics, and cognitive psychology, given the predominate focus on intra-individual language processing. Models of phonological, syntactic, and semantic processing consequently do not explain how processing occurs in response to the communicative context, from which language cannot be divorced. Failure to take into account the constraints imposed by the finite nature of human communication may lead one to a model that represents how humans process language in "interacting" with themselves, but not how they process it in interacting with one another. Such a model would also be a questionable step toward the goal.

Yet this sketch of the cognitive and the communicative constraints merely hints at the nature of their interaction. Both sets of constraints are essential in studying language because they arise from complementary aspects of WHO does languaging. Specifically, a human language exists in a "useable" form only as the patterns underlying its phonology, syntax, meaning, and use are cognitively represented or "stored" in the language using individual. Dead or undeciphered languages "exist" in a limited sense in written or graphic form, but unless their structures are cognitively represented by some human being, they remain quite literally "dead" or unuseable.

But this requirement of cognitive representation in human beings is only a necessary, not a sufficient condition for the existence of a human language. It is also necessary to have communication using that language, for a language cannot evolve nor be maintained across time except through interaction in a social matrix. In this respect, the patterns underlying phonology, syntax, meaning, and use transcend individuals, for they exist only by social agreement and are not, except in minor ways, subject to individual action (cf. Wittgenstein, 1953, and Burke, 1966, among many others). Written or graphic forms are again of no import, in that both evolutionarily and developmentally the ability to speak a language precedes the ability to read or write one.

Perhaps most significant, however, is the interaction of cognition and communication: At this point in human evolution, a language comes to be cognitively represented in an individual only through his or her communication with other individuals in a social matrix. Acquiring the ability to process a given language proceeds only by acquiring the ability to communicate in it. The two are inseparable: language processing does not occur except in a communication context (cf. Rommetveit, 1974, pp. 61-68). Here too, "acquiring" a dead or undeciphered language is no exception -- to do so one must know or make fundamental assumptions about communicative use. Finally, the fact that the patterns underlying communicative use must also be cognitively represented, along with the patterns of phonology, syntax, and meaning, does not make the cognitive representation primary, for without the communication among individuals there would be no language patterns to represent.

Because cognition and communication are jointly necessary for human languaging to exist, it is clear that models of HOW language is processed (and of WHAT it is) must be constrained by both cognitive capablilities and communicative use, as complementary aspects of WHO does languaging.[7] Not to do so is to build models that provide at best a limited understanding and [illegible]tion of how communicating human beings produce and [illegible] language. But to this point, the argument for the [illegible] of considering WHO does languaging in studying HOW it [illegible] has been made primarily on abstract grounds. It remains to be shown that the constraints imposed by the cognitive and communicative aspects of WHO have direct implications for the conduct of research on language in cognitive psychology and human communication.

Cognitive constraints, and the computational paradigm

The work of Miller and Johnson-Laird (1976) on procedural semantics functions as a focal point for considering the implications of constraints arising from cognitive capabilities. Their work serves as a focus both because it is representative of research on language in the computational paradigm, and because the authors' primary concern is with the representation of meaning. More specifically, Miller and Johnson-Laird's work, like that of a number of others using computational analogies (for example, Schank, 1972, 1975; Wanner and Maratsos, 1975; Winograd, 1972; Woods, 1970), makes explicit use of algorithmic or procedural formalisms to model HOW sentences are assembled and disassembled, as well as both WHAT meaning is and HOW it is processed. Miller and Johnson-Laird do not actually write computer programs, but their model of

meaning, as indicated earlier, represents meanings in closely interwoven sets of computational procedures, linked on one hand to a perceptual base and on the other to core concepts.

In focussing on meaning, Miller and Johnson-Laird directly confront a central problem in research on language in the computational paradigm: How is meaning to be represented such that algorithms for assembling sentences can express meanings already acquired, and those for disassembling can "capture" meanings and act upon them, as for example in responding to a question? Just how to represent meaning for these purposes is the subject of considerable debate, as in discussions of procedural versus declarative representations (Winograd, 1975), of propositional forms (Knitsch, 1974), perhaps as opposed to analogic forms (see Szczepkowski, 1978), and in considerations of several other approaches (see Bobrow and Collins, 1975). But this debate has not stifled research, for there have been in existence for some time a number of highly complex algorithms which conduct meaningful discourse with humans about limited domains of knowledge, and do so in a non-trivial way (for example, Winograd, 1972). That such systems work, that is, do languaging, is testimony to the partial validity of the modes for representing meaning and for processing sentences that have been developed thus far.

Yet as suggested earlier in discussing the importance of WHO in studying language, the class of algorithms or procedures that can in principle process sentences, and more centrally, that can represent meaning, is larger than the class of procedures that can be realized in the human organism given the finite

nature of human cognition.[8] If the goal of research on language in the computational paradigm is to explain HOW humans produce and understand language, then it is necessary to constrain the models being developed to what is realizable in terms of human cognitive capabilities for processing sentences and for representing meaning. Winograd (1977, pp. 168-169) has recently acknowledged this point, but it appears in general that the constraints imposed by the cognitive aspects of WHO does languaging have not been thoroughly considered, even by Miller and Johnson-Laird (cf. Shaw and McIntyre, 1974, pp. 311-316).

Why so little attention to cognitive constraints? Apparently because the problems of creating algorithms which do languaging are in themselves so complex that these "extra" constraints appear less important. Certainly the problem is not the lack of information which might provide specific constraints. Simon (1969, pp. 31-46), for example, has pointed to a number of fairly straightforward factors like speed of processing and the basic organization and parameters of memory as important constraints on the complexity and power of algorithms in the computational paradigm. Hence even basic texts in cognitive psychology (like Neisser, 1967) can provide a wide range of constraints to be taken into account, both in modeling sentence processing and in developing representations of meaning.

More specifically, research on the viability of features systems as a model of human representation of meaning (for example, Fodor, Fodor & Garrett, 1975; Palermo, forthcoming, Ch.7) may provide directly relevant constraints, given that many

semantic models in the computational paradigm use this approach (see Johnson-Laird, 1977, p. 212). Similarly, despite the current debate, research on propositional (Kintsch, 1974) and on analogic (Bransford & McCarrell, 1974, pp. 220-224; Brewer, 1974, pp. 282-284) representations also provides constraints. At a more fundamental level, the work of neuropsychologists like Pribram (1971) on memory structures and processing has developed to the point that it provides non-reductive constraints for models of cognitive representation. And more generally, current research in perception, such as that by Gibson (see Mace, 1974), as well as existing cognitive research tied to meaning (Brewer, 1974), provides both frameworks and constraints within which to model the representation of meaning in humans.

Clearly this review of sources for cognitive constraints is neither comprehensive nor exhaustive. New information on these constraints is much needed, but a great deal is already available and needs to be taken into account in developing models in the computational paradigm. Such constraints are necessary not only for models of HOW sentences are assembled and disassembled, but also, and more importantly, for models of WHAT meaning is and HOW it is processed.[9] The emphasis on meaning, both here and in the above review, reflects a particular position on the study of language already apparent in this paper, namely, that an understanding of the nature of meaning is a central component in an understanding of human languaging. Weimer (1974) makes this point cogently, but goes on to argue that "the problem of meaning becomes that of the representation of information within the [central nervous system]

(p. 429; cf. Martin et. al., 1974)." The implication for research is direct: To the extent that the representations of meaning employed in work in the computational paradigm differ from the human cognitive representation of meaning, those models are are restricted in their ability to explain HOW humans do languaging.[10]

Lakoff and Thompson (1975b) thus appear justified in urging that research on language move toward developing a "cognitive grammar" which focusses both on the actual procedures humans use to process sentences, and on the link between the linguistic signal and the cognitive representation of meaning. (The two problems that brought recent psycholinguistics to its impasse.) But Lakoff and Thompson, like Miller and Johnson-Laird and others, have paid only minimal attention to the fact that the cognitive capabilities of WHO does languaging impose constraints on models of HOW language is processed and of WHAT meaning is -- constraints which are essential in order for those models to converge on explanations of how human beings produce and understand language.

Communicative constraints, and the human behavior paradigm

Cognitive constraints are essential, but again, not sufficient. The constraints arising from the communicative use of language are equally important in that cognition and communication are jointly necessary for human languaging. The work of Bransford and McCarrell (1974) on sentence comprehension serves as a focus for considering the implications of communicative constraints, both because their work exemplifies research on language in the human behavior paradigm, and because they are primarily concerned with

the role of nonlinguistic knowledge in understanding language. Before examining their work in detail, however, it is important to consider how research in the human behavior paradigm differs from work in the computational paradigm in cognitive psychology.

The broad goal in both paradigms is the same: To understand the nature of human cognition in all its aspects, the understanding and producing of language being one of these. Hence the primary differences between the computational paradigm and what has been termed here the "human behavior paradigm" lies in their approaches to developing models of cognitive processes, to deriving implications from them, and to testing the models. In the computational paradigm, researchers both construct models of HOW a particular cognitive process might be carried out, and do so at a level of detail that allows the process to be simulated ex vivo. Frequently they utilize formalisms developed in the study of computation, for example, flowcharts, algorithmic structures, or programming languages, though using a computer is not necessary for simulation. The implications of the model are isolated by carrying out a simulation with selected materials, as in completing a cloze test via a languaging processing algorithm. The model is tested by comparing the results of the simulation to human behavior with the same materials. Note that while some researchers build models which are analogs of computer operations (Miller and Johnson-Laird, 1976), this is not a necessity--computational algorithms are general purpose tools and need not simulate a computer (see Winograd, 1977, for a discussion of some of these issues with regard to language models).

Researchers working in the human behavior paradigm, on the other hand, construct models using a larger set of abstract calculi, since the primary concern is to characterize the aspect of cognition under study in some principled way. There is no necessity to model HOW the process operates, or to do so at a level of detail that allows simulation. The implications of the model are derived by specifying a set of "conditions of operation" and by performing formal operations on the calculus to identify the corresponding consequences. The model is tested by developing materials and situations which it is assumed will generate the specified conditions of operation in vivo, and the resulting human responses are compared with the predicted consequences. Research in the human behavior paradigm obviously predominates in cognitive psychology (cf. Brewer, 1974; Neisser, 1967).

The concern with these two paradigms in this paper stems from the fact that models in the human behavior paradigm are necessarily subject to the constraints imposed by human cognitive capabilities, since the only cognitive processing involved occurs in vivo. Models in the computational paradigm are not necessarily subject to these constraints since the primary concern is with the nature of the "cognitive" processing which occurs ex vivo in the simulation. This difference provides advantages and disadvantages which complement one another: Models in the human behavior paradigm are subject to cognitive constraints in that those models which violate them should fail to receive empirical support. Models in the computational paradigm are not subject to cognitive constraints in that these models may employ procedures very different from those of humans,

yet still produce the same results as humans. On the other hand, the constraints operative on models in the human behavior paradigm are virtually always implicit, while the constraints on models in the computational paradigm are in almost all cases explicit.[11]

In studying language processing in the human behavior paradigm, then, Bransford and McCarrell's (1974) model of sentence comprehension is implicitly constrained to human cognitive capabilities for sentence processing and representation of meaning. In effect, they sidestep the issues that were seen as problematic for Miller and Johnson-Laird (1976) by treating processing and especially meaning as "undefined primitives" (Weimer, 1974, p. 430; cf. Rosch, in press). As sketched earlier, Bransford and McCarrell's model and related research indicate that humans process sentences at the linguistic level in a way which identifies both the entities involved, and the specified conditions on and relationships among them. However, individuals do not comprehend what the sentence means as a whole until they create from or recognize in their nonlinguistic knowledge a context in which the specified relationship can be realized. The nonlinguistic knowledge involved is a product of perception and learning, and is sufficiently complex and multifaceted that only some aspects of it are immediately available at any one time for use in comprehending a sentence. Very frequently, the verbal context which precedes a sentence will bring into use that part of the nonlinguistic knowledge needed for understanding. When this happens, the given sentence is comprehended as soon as (or even before) it is processed at the linguistic level.

In recent years, there has been a definite increase in the number of cognitive psychologists studying the processing of sentences in such verbal contexts, as in the work on text processing of Frederickson (1977) and Kintsch (1974). This research is an important move away from the rather limited perspective on language engendered by studies of sentences in isolation (a tendency inherited from linguistics, see Rommetveit, 1974). But much of the research on texts is concerned with WHAT the structure of a text is at the linguistic level, or with HOW humans process a text at this level.[12] Against this background, Bransford and McCarrell's contribution is two fold: They show that processing a text at the linguistic level is not sufficient for understanding (1974, pp. 204-207), and at the same time they provide a model of HOW human comprehension takes place at the higher level of nonlinguistic knowledge (see also Brewer, 1974, pp. 284-292; Weimer, 1974, pp. 421-425). That Bransford and McCarrell's model more accurately represents sentence comprehension can be seen in the fact that, unlike the lower level text processing models, it allows the obvious possibility that the nonverbal events surrounding a sentence may also bring into use the nonlinguistic knowledge needed to comprehend.

Yet in developing their model and in conducting their research, Bransford and McCarrell have operated on the unstated assumption that isolated individuals are the locus of language use, not realizing that with regard to language, an isolated individual is perhaps a greater anomaly than an isolated sentence. In short, they have failed to recognize that language processing does not occur except in a communication context. More

specifically, Bransford and McCarrell have not considered the the essential contribution of the communicative use of language to the comprehending of sentences.

That the communicative use is essential is easy to demonstrate: Assume you and I have just completed a tour of a feed lot at which cattle are gorging themselves on grain in preparation for market. Prominent in several of the pens was a large haystack, and in our puzzling over this fact, I remark, "The haystack was important because the cattle were starving." You will certainly process the sentence at the linguistic level, but will have trouble comprehending it unless you realize that I am being sarcastic. Sarcasm, however, is a fairly complex function not only of our preceding verbal and nonverbal communication and experiences, but also of the particular communicative relationship which exists between us at that moment. Note that in this case your comprehension of the sentence cannot be explained solely on the basis of your nonlinguistic knowledge of cattle, feeding habits, etc., in use at the point of my utterance--the nature of the communicative act itself is also essential. That many sentences seem to be comprehended without taking into account the communication act is not an indication that the communicative use of language is only important in problematic cases. Rommetveit (1974) has argued in detail that the communicative framework is essential in every use of language.[13]

Because of its development in the human behavior paradigm, then, Bransford and McCarrell's model of HOW humans comprehend sentences is implicitly constrained by the cognitive capabilities

of WHO does languaging. But even given these constraints, it is evident from the earlier discussion of the importance of WHO that the class of models which are in principle capable of representing sentence comprehension is larger than the class that can be realized in the human organism, given the finite nature of human communication. If the goal of research in the human behavior paradigm is to explain HOW communicating human beings produce and understand language, then is is necessary to constrain models like Bransford and McCarrell's to what is realizable both in terms of the communicative use of language, and in terms of human cognitive capabilities. Bransford and McCarrell are by no means alone in overlooking what the communicative context provides. Almost all psycholinguists and cognitive psychologists studying language have done likewise, whether they have focussed on understanding of language, or on its production (where non-linguistic knowledge and communicative context are equally important).

The lack of attention to communicative constraints appears to stem from the predominately intra-individual focus of cognitive psychology, coupled with the general failure to recognize the constraints imposed by WHO carries out a psychological process (as in Shaw and McIntyre, 1974). The problem is not one of lack of information on specific constraints. Cappella (1972), for example, has identified a set of prerequisites for communication which constitute what are perhaps the most basic communicative constraints. At a slightly higher level, Clark and Haviland (1977) have examined what they term the "given-new" contract which individuals follow in relating new information

to that which is assumed to be known. This contract between communicating individuals must be adhered to for comprehension to occur, and constitutes another fundamental constraint. Clark and Haviland relate their work to Grice's "cooperative principle" in communication, as does Lakoff (1973) in examining the essential place of politeness in constructing and comprehending sentences. At a higher level yet, Searle (1969) has enumerated the constraints necessary in a communication situation in order that sentences be comprehended as promises, requests, advice, etc., while Nofsinger (1976) has examined the conditions for understanding indirect answers to questions, a situation with many of the complexities of sarcasm.

And the sources do not stop here. Rommetveit (1974) provides a framework for studying the means by which the communicative context brings into use the knowledge necessary for comprehension. Indeed, he shares sufficient commonality with Bransford and McCarrell that his framework may be useful in bringing a consideration of communicative constraints into their work. Finally, at what may be the highest or broadest level, sociolinguists like Halliday (1977) and Hymes (1974) have examined communicative constraints that stem from the society or culture in which individuals learn to interact.

This review of sources for constraints is merely representative, for greater breadth or depth is not possible here. Clearly much is already known about communicative constraints on HOW humans comprehend sentences. Yet a great deal more remains to be learned, both about these constraints, and about concerns excluded from the review, such as the nature of the information

provided in comprehending sentences by the nonverbal aspects of communication (for example, turn-taking and nonverbal vocal characteristics). Certainly approaches such as conversational analysis (Nofsinger, 1977) can be expected to provide some of this information, as can more traditional approaches to research on human communication.

This discussion of communicative constraints reflects two basic positions developed earlier, namely, that cognition and communication are jointly necessary for human languaging, and that an individual acquires his or her language only by acquiring the ability to communicate in it. The first suggests that the earlier implication regarding the place of cognitive constraints in research does not go far enough. The second position provides the needed addition: To the extent that the models of language processing constructed in the human behavior paradigm fail to recognize and incorporate the communicative use of language, those models are restricted in their ability to explain HOW humans do languaging.

Because they implicitly avoid Miller and Johnson-Laird's lack of attention of the cognitive capabilities of WHO does languaging, Bransford and McCarrell make some progress in avoiding the impasse which psycholinguistics faced regarding the nature of human language processing and meaning. But along with others, Bransford and McCarrell have not recognized that the communicative use of language is an important aspect of WHO does languaging and a source of constraints on models of HOW language is processed--constraints which are essential,

along with cognitive constraints, for those models to converge on explanations of how communicating human beings produce and understand language.

Comments on cognitive and communicative constraints

Attaining the goal restated above quite clearly requires knowing more about WHO produces and understands language. Considering WHO strongly influences the understanding of HOW language is processed, and of WHAT language is, yet the influence is not one way. The three questions are closely inter-related. If framing the right question is an essential component in finding an adequate answer, then one implication is that research on human languaging must carefully consider all three questions.[14]

But the interaction among these three questions is not the only "close inter-relationship" which has emerged in this discussion. Cognition and communication are not only closely related, but also complementary and inseparable components of human languaging. Indeed, these joint necessities for language reflect a broader and more basic principle, namely, that in studying WHAT humans do or HOW they do it, the WHO question has closely inter-related individual and social components. This point, together with the close inter-relationship between acquiring a language and acquiring the ability to communicate in it is the basis for the close inter-relationship between cognitive constraints and communicative constraints, and leads to the implication that research on human languaging must thoroughly consider both constraints.

And the discussion of these two sets of constraints has involved still another close inter-relationship--that between the human behavior paradigm and the computational paradigm. Not only are both essential in research on language in cognitive psychology, given that they complement one another, but they are also both essential in human communication research on language, especially in view of the almost complete domination of the human behavior paradigm. Indeed, the disciplines of cognitive psychology and human communication are also closely inter-related in the study of human languaging, for both have essential information to offer. Cognitive psychologists cannot be expected to become communication scholars, nor the reverse, which provides perhaps the broadest implication of all: Research on human languaging must be seen as an interdisciplinary venture.

Notes

1. As Maclay (1971) suggests, interpretative semantics was added to syntax to resolve problems in transformational grammar which could not be handled in syntax alone. Generative semantics makes semantics considerably more central, but also employs paraphrase approaches. Despite appearances, generative semantics does not model HOW humans actually process language. I have avoided using the competence/performance distinction in this paper because of the considerable confusion generated by common usage vs. linguistic usage, and because of the growing confusion in linguistic (Maclay, 1971, pp. 179-180) and in psycholinguistic usage (Cairns and Cairns, 1976, pp. 181-184).

2. I have not discussed communication research related to language in this review because, with few exceptions, communication scholars have not focussed on the structure of language or on how humans process those structures, in the sense those phrases are used here. Language qua language is normally "transparent" in communication research, in that investigators are primarily concerned with the "content" of the language used, or with its "effects" in some communication context. Even studies of "message variables" or "stylistic features" tend to share this perspective, in that they focus on global effects and sidestep linguistic and especially cognitive models of language processing.

3. I will not argue whether Miller is "really" a psycholinguist or a cognitive psychologist. He is a psychologist's psychologist, and his recent work (1976) is quite clearly cognitive psychology when compared with the psycholinguistics he produced when he joined the "transformational bandwagon."

4. Parallel constraints apply to machines, where the limits are imposed by design, not evolution, and by physical rather than biological structures. Abstract automata including universal Turing machines may be in principle capable of computing any function, but cannot necessarily do so within the limits of real time, space, or structure (Shaw and McIntyre, 1974, pp. 316-318).

5. A very similar comment could be made regarding recent developments in human communication theory and research. A number of recent articles can be seen as calls for the discipline to turn from simply asking WHAT constitutes communication, to modeling HOW people accomplish it, for example, Delia (1977), Frentz and Farrell (1976), Hawes (1977), among others. The constraints imposed by the nature of WHO does communication are not ignored, but the predominant emphasis at this point in time appears to be on the HOW questions. These developments are not discussed in this paper because the goals in studying communication (which must include the

non-verbal) are not the same as the goal of studying language expressed at the outset. The constraints imposed by WHO does communicating are parallel to those found in studying language, but to develop them is beyond the scope of this particular paper.

6. This does not deny that other life forms may have "languages" used for communication. Rather, the concern here is solely with languages having the distinct form of human languages, as studied in linguistics, psycholinguistics, cognitive psychology, etc.

7. Clearly, the complementarity which holds between cognition and communication has much broader implications for the conduct of inquiry than are suggested here. To expand on these is beyond the scope of this paper; however, work is presently underway to develop the importance of social/communicative organization for the framework presented in Shaw and McIntyre (1974).

8. Again, this constraint from "in principle" to "realizable" is only the first of the pair of general constraints discussed earlier (p. 9). The second of the pair, or the constraint from "in principle" to "particular" serves to further reduce the class of possible algorithms to those capable of processing the particular type of information structures which have evolved as human languages. This second constraint of HOW by WHAT is in many ways implicit in considering the first constraint of HOW by WHO, and cannot be isolated from it. Explicit development of the second general constraint is again not possible in a paper of this length.

9. Constraints to known human cognitive capabilities are equally necessary in other research in the computational paradigm that seeks to model human activity, models of perception being primary (cf. Shaw and McIntyre, 1974, pp. 311-316). Such constraints are needed in addition to the validation of simulation results against human behavior. Note that the concern here is not to admonish researchers to be aware that human beings are not structured like computers. Researchers in the computational paradigm readily acknowledge this point. The concern is that researchers move beyond this "passive" awareness to an active seeking out and using of information on differences and constraints.

10. Weimer, in the same article (1974, pp. 438-440), expresses but cannot pinpoint his apprehension that Miller's (1974) new "third," or computational, metaphor may lead cognitive psychology to a dead end, as have Miller's earlier metaphors for the discipline. Earlier in the same discussion, Weimer (pp. 430-432) strongly endorses Shaw and McIntyre's (1974) argument for considering WHO, together with HOW and

WHAT. Curiously, Weimer fails to see that it is precisely Shaw and McIntyre's point that explains the limiting aspects of Miller's computational metaphor.

11. Note that in both paradigms the advance of inquiry is disrupted by accepting models on the basis of insufficiently detailed studies or of insensitive designs and tests. There is a substantial amount of research in the human behavior paradigm which seeks to make cognitive constraints explicit, but such work has somewhat different goals from that considered here, and does not deny the complementary between the paradigms.

12. I have omitted discussion of work in discourse and text analysis, as reviewed in Dressler (1977) or van Dijk (1977). This work is not irrelevant, but is largely outside the human behavior paradigm and is uniformly focussed on WHAT constitutes the structure of a text. The latter concern is also evident in work on texts in the computational paradigm, and while some of this work does consider HOW texts are processed at the linguistic level, there is very little concern with modeling HOW humans comprehend the text (Schank, 1972, 1975).

13. Bransford and McCarrell (1974, pp. 218-219) make a similar point regarding the place of nonlinguistic knowledge. It seems clear that one unexamined influence on virtually all studies on language in the human behavior paradigm is the effect of the particular (and highly unique) communicative context which constitutes an experiment.

14. The frequent reference to WHAT, HOW, and WHO may have reminded some of Lasswell's 1948 verbal model of communication: "Who says what in which channel to whom with what effect." Lasswell obviously omitted the HOW question, and the history of communication research in the 30 years since his model makes clear that researchers promptly forgot the WHO and WHOM, have focussed to some extent on WHAT is said, and have devoted most of their energies to considering <u>which</u> channel, and especially <u>what</u> effect (see also note 2).

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